ASMi-31

Short Range Modem

Installation and Operation Manual

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Telecommunication Safety

The safety status of each of the ports on ASMi-31 is declared according to EN 41003 and is detailed in the table below:

Ports	Safety Status
V.24, V.35, X.21, RS-530, V.36, LAN, balanced G.703	SELV Circuit operating with Safety Extra-Low Voltage
Line	TNV-1 Telecommunications Networks Voltage within the limits of SELV and subject to overvoltages.

Regulatory Information

FCC-15 User Information

This equipment has been tested and found to comply with the limits of the Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to the radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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This is a Class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

Declaration of Conformity

Manufacturer's Name: RAD Data Communications Ltd.

Manufacturer's Address: 12 Hanechoshet St.
                                  Tel Aviv 69710
                                  Israel

declares that the product:

Product Name: **ASMi-31/S**

Conforms to the following standard(s) or other normative document(s):

EMC:	EN 55022 (1994)	Limits and methods of measurement of radio disturbance characteristics of information technology equipment.
	EN 50082-1 (1992)	Electromagnetic compatibility – Generic immunity standards for residential, commercial and light industry.
Safety:	EN 60950 (1992/93)	Safety of information technology equipment, including electrical business equipment.

Supplementary Information:

The product herewith complies with the requirements of the EMC Directive 89/336/EEC and the Low Voltage Directive 73/23/EEC. The product was tested in a typical configuration.

Tel Aviv, September 7th, 1997

Haim Karshen
VP Quality

European Contact: RAD Data Communications GmbH, Lyoner Strasse 14, 60528 Frankfurt am Main, Germany

Quick Start Guide

If you are familiar with ASMi-31, use this quick start guide to prepare the unit for operation.

Perform the following steps for both the local and the remote units.

1. Disconnect all cables from the units.

2. Open the case of the units.

3. Adjust the jumpers (see *Chapter 2, Installation and Setup*).

Note   *Make sure that there is only one clock source in the application. Select one modem as INT or EXT, and the second modem as RCV.*

4. Close the case of the units.

5. Connect the units to the DTEs.

6. Power up the units.

7. Connect the units to the line.

The units should operate properly after a few seconds.

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Chapter 1

Introduction

This chapter describes basic physical and functional features of the ASMi-31 standalone modem, as well as some typical applications. It discusses the following topics:

* An overview of the modem

* Physical description

* Functional description

* Technical specifications.

1.1 Overview

General

The ASMi-31 modem is a synchronous/asynchronous short-range modem which is managed by a remote master modem. ASMi-31 operates synchronously or asynchronously at full duplex over 2-wire twisted pair, unconditioned lines. The ASMi-31 modem has a transmission range of 8 km (5 miles) over 24 AWG wire and operates at user-selectable data rates from 1.2 kbps to 128 kbps.

Versions

ASMi-31 is available in several versions:

* **ASMi-31 standalone** – the standalone slave unit features a blank panel

* **ASMi-31/R** – a plug-in card which may be installed in the ASM-MN-214 hub.

* **ASMi-31C** – a plug-in card which may be installed in the LRS-12 or LRS-24 hub (see *ASMi-31C Installation and Operation Manual* for details).

Power Supply Versions

The power supply options are:

* AC power source: 115 VAC or 230 VAC

* DC power source: -48 VDC.

Application

Figure 1-1 illustrates the ASMi-31 application.
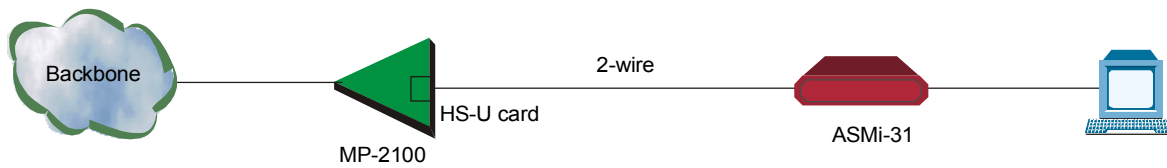
Figure 1-1 ASMi-31 Working Opposite HS-U Card in Megaplex-2100

Features

The ASMi-31 short range modem supports full duplex transmission over 2-wire twisted pair unconditioned lines.

The ASMi-31 modem operates in pairs with either another standalone modem, or as a card installed in the ASM-MN-214 hub.

A management channel transmitted in-band allows remote configuration for the modem, real-time alerts on failures, and diagnostic testing. The line data rate is selectable from 1.2 kbps up to 128 kbps and the line encoding is 2B1Q. ASMi-31 achieves an operating range up to 8 km (5 miles) over 24 AWG wire, independent of data rate.

The ASMi-31 modem is fully compatible with ASM-31 and SRM-31 and works opposite MP-2100/HS-U module.

The ASMi-31 modem features automatic rate detection in external clock mode for tail-end applications.

Control Signal Transfers

ASMi-31 supports end-to-end transfer of two control signals: DTR to DSR and RTS to DCD, except for the V.35 interface or any other standard that doesn't support this signal (such as X.21, G.703).

Interfaces

ASMi-31 supports the following interfaces: V.24/RS-232, V.35, X.21, V.36/RS-449, RS-530, G.703 Codirectional, or built-in Ethernet bridge.

Diagnostics

ASMi-31 contains two diagnostic loops for complete diagnostics of both local and remote modems:

- Local analog loopback

- Remote digital loopback

Both loopbacks are controlled via pins in the DTE interface and are supported by their respective standards.

1.2 Physical Description

ASMi-31 is available as a standalone desktop unit or as a card for the ASM-MN-214 hub. *Figure 1-2* shows the 3D view of the ASMi-31 standalone unit.
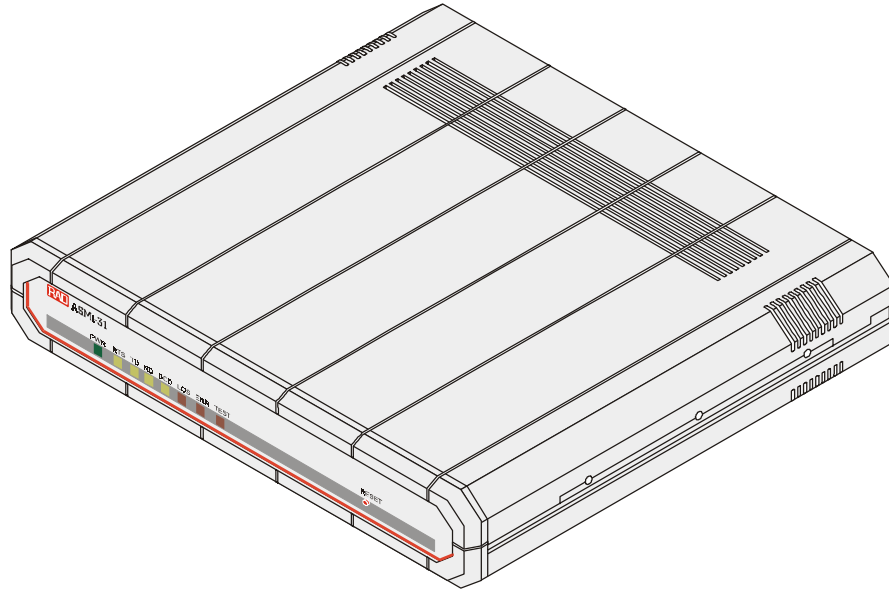
Figure 1-2 ASMi-31 Standalone Unit

The front panel includes eight LEDs, which display the status of power, data flow, control signals and diagnostics. For detailed description of the front panel, see Chapter 3, *Operation*.

The back panel includes an power connector with fuse, an interface connector, and a terminal block with a ground connection for connecting the telephone lines. The ASMi-31 rear panel is described in greater detail, in Chapter 2, *Installation and Setup*.

The internal switches and jumpers can be configured to support a variety of modes for operating the modem. Refer to *Setting the Internal Jumpers* in Chapter 2 for details on jumper location and setting.

1.3 Functional Description

General   The ASMi-31 standalone modem is managed by a master ASMi-31C modem card mounted on a LRS-12 or LRS-24 hub. The management channel, which is transmitted in-band, allows remote configuration, real-time alerts on system failure, diagnostic testing, and the production of statistical information on system performance.

Remote Management

The ASMi-31 standalone modem is very conveniently managed from the master station by means of RADview, a RAD SNMP application. This user-friendly graphical user interface manages the ASMi-31C modem cards installed in the LRS-12 or LRS-24 hub and, through them, the ASMi-31 standalone units.

Both data and management are transmitted inband over the same line, simultaneously, without interference.

Data Transmission

Full duplex operation over 2-wires is achieved using the adaptive "echo-canceling" technique. The ASMi-31 modem uses 2B1Q line coding to achieve the range of 8 km/5 miles, for all data rates. This coding provides immunity to background noise, eliminates normal line distortion and permits efficient transmission over 2-wire twisted cables.

An adaptive equalizer provides noise immunity and high performance over low quality lines.

Special Management Configurations

The ASMi-31 standalone modem unit has internal jumpers which allow for special management configurations such as point-to-point applications without ASMi-31C modem cards in the LRS-12 or LRS-24 hub, and also on-site diagnostics testing.

Diagnostic Capabilities

In addition to the remote diagnostic capability, the ASMi-31 standalone modem provides diagnostic capabilities which can be executed locally. These include the Digital Loopback (RLB) and Analog Loopback (LLB) diagnostics; they are executed via the DTE interface after the appropriate jumpers are set. The ASMi-31 unit has a blank panel to prevent unauthorized operation at the customer premises.

The local diagnostics are as follows:

- **Remote Digital Loopback** – REM, activated by pin in DTE interface and supported by respective standard.

- **Analog Loopback** – Local (ANA defined by the standard as LLB), activated by pin in DTE interface and supported by the respective standard.

Note   *The ASMi-31 loopbacks do not operate with the X.21 and G.703 (Codirectional) because they are not supported by these standards.*

Overload Protection

The ASMi-31 modem is coupled to the line through an isolation transformer which protects against AC or DC overvoltages. The protection circuitry permits operation even when DC is connected to the line.

1.4 Technical Specifications

Line Interface	*Type*	2-wire, full duplex unconditioned telephone line (twisted pair), using echo-cancellation
	Line Coding	2B1Q
	Range	Up to 8 km (5 miles), over a 24 AWG wire, independent of data rate
	Level	Up to 14 dBm (assuming a 135Ω load)
	Connector Type	3-clip terminal block and RJ-45 connector
	Standard	Complies with ANSI T1.601.1988 specifications
Digital Interface (DTE)	*Types*	ITU V.24/RS-232, V.35, RS-530 or X.21, G.703 Codirectional (64 kbps), Ethernet (10BT), Ethernet 10B2 (BNC)
	Data Rates	1.2 kbps to 128 kbps

Connectors

- V.24 – 25-pin, D-type female
- V.35 – 34-pin, female
- V.36 – 37-pin, D-type female, via supplied cable adapter
- X.21 – 15-pin, D-type female
- RS-530 – 25-pin, D-type female
- G.703/TB – Terminal Block
- G.703/RJ – RJ-45, female
- Ethernet (10BaseT) – RJ-45, conforms to IEEE 802.3
- Ethernet (10Base2) – BNC

Clock Source	*Master Clock*	**Internal clock** – The master clock uses its own internal crystal when transmitting or receiving data from the DTE interface and from the line.
		External clock – The master clock uses the clock derived from the digital interface to receive data from the DTE and for transmitting data to the line. If the digital interface is X.21, the same clock is used to transmit and receive data.
	Slave Clock	**Loopback timing** – The clock is recovered from the line signal and used to transmit and receive data from the DTE interface to the line.
Control Signals		Jumper-selectable: • RTS to DCD • DTR to DSR
Diagnostics	*Loopback Tests*	**Remote Digital Loopback** – REM activated by pin in DTE interface supported by the appropriate standard
		Analog Loopback – Local (ANA defined by the standard as LLB) activated by pin in DTE interface supported by the appropriate standard
Indicators	*PWR (green)*	Power
	RTS (yellow)	Request To Send (Circuit 105)
	TD (yellow)	Transmit Data (Circuit 103)
	RD (yellow)	Receive Data (Circuit 104)
	DCD (yellow)	Data Carrier Detect (Circuit 109)
	LOS (red)	Loss of signal
	ERR (red)	Error is detected in received configuration information
	TEST (red)	A test is active
Power	*AC Voltage*	115 VAC or 230 VAC (10%), 5W
	Frequency	50 or 60 Hz (47 to 63 Hz)
	DC Voltage	-48 VDC (-36 to -72 VDC)
	Power Fuses	0.1A, slow-blow for 230V

		0.2A, slow-blow for 115V
Physical	*Height*	4.4 cm / 1.7 in
	Width	19.3 cm / 7.6 in
	Depth	24.3 cm / 9.6 in
	Weight	1.5 kg / 3.3 lb
Environment	*Temperature*	0°-50° C / 32°-122° F
	Humidity	Up to 90%, non-condensing

Chapter 2

Installation and Setup

This chapter provides the following information for the ASMi-31 standalone model:

- Site requirements and prerequisites

- Package contents

- Instructions for mechanical installation

- Instructions for electrical installation.

After installing the unit, refer to *Chapter 3* to assure normal operation.

In case a problem encountered, refer to *Chapter 4* for test and diagnostic instructions.

Refer to *Chapter 5* for additional information on the ASMi-31/R card version.

2.1 Site Requirements and Prerequisites

Power

AC-powered ASMi-31 units should be installed within 1.5m (5 ft) of an easily accessible grounded AC outlet. The outlet should furnish 115 VAC or 230 VAC.

DC-powered ASMi-31 units require -48 VDC power source, which must be adequately isolated from the mains supply.

- Allow at least 90 cm (36 in) of clearance at the front for operating and maintenance accessibility.

- Allow at least 10 cm (4 in) clearance at the rear of the unit for signal lines and interface cables.

Ambient Requirements

The ambient operating temperature of ASMi-31 is 0 to 50°C (32 to 122°F) at relative humidity of 90%, non-condensing.

2.2 Package Contents

- One ASMi-31 unit (protected by adequate cushioning)

- AC power cord or DC power supply connector kit

- ASMi-31 Installation and Operation Manual

- Interface adapter cable(s) (see *Table 2-2*) - Optional.

2.3 Installation and Setup

ASMi-31 is a standalone device intended for tabletop or bench installation. It is delivered completely assembled. No provisions are made for bolting ASMi-31 to the tabletop. For installation of the unit in a 19" rack, refer to *Appendix F*.

➤ **To complete the installation of ASMi 31:**

1. Determine the required configuration of the modem according to your application, and set the internal jumpers and switches accordingly *(see and .

2. Connect the line (see *Connecting the Line* below).

3. Connect the DTE interface (see *Connecting the DTE* below).

4. Connect power to the unit (see *Connecting the Power* below).

Setting the Internal Jumpers

This section provides information on the functions of the internal jumpers and switches, to help you in the selection of the correct settings for particular application, and gives you step-by-step instructions for performing the internal settings. The default settings are also listed.

1. Open the ASMi-31 case.

2. Set the ASMi-31 internal jumpers and switches, referring to *Figure 2-1* and *Table 2-1*.

3. Reinstall the ASMi-31 cover.

⚠ **Warning**

Access to the inside of the equipment is permitted only to the authorized and qualified personnel.

To avoid accidental electric shock, always disconnect the interface cables and the power cord before removing the unit from its casing.

Line voltages are present inside ASMi-31 when it is connected to power and/or the lines. Moreover, under certain fault conditions, dangerous voltages may appear on the lines connected to the unit.

Any adjustment, maintenance and repair of the opened instrument under voltage must be avoided as much as possible and, when inevitable, should be carried out only by a skilled technician who is aware of the hazard involved. Capacitors inside the unit may still be charged even after the unit has been disconnected from its source of power.

Caution

ASMi-31 contains components sensitive to electrostatic discharge (ESD). To prevent ESD damage, avoid touching the internal components, and before moving jumpers, touch the ASMi-31 frame.

Opening the ASMi-31 Case

To reach the internal jumpers and switches of ASMi-31, it is necessary to open its case.

➤ **To open the ASMi-31 case:**

1. Disconnect all the cables connected to ASMi-31.

2. Turn the unit over (bottom facing up).

3. Unscrew the four cover screws.

4. Turn the unit over (bottom facing down).

5. After the four screws released, remove the ASMi-31 top cover by pulling it straight up.

Setting the Internal Jumpers and Switches

The internal jumpers and switches located on the ASMi-31 printed circuit board (PCB) are identified in * *Baud* rates not applicable.

Figure 2-1. Their numbers under heading "Item" in *Table 2-1* correspond to the identification numbers shown in *Table 2-1*.
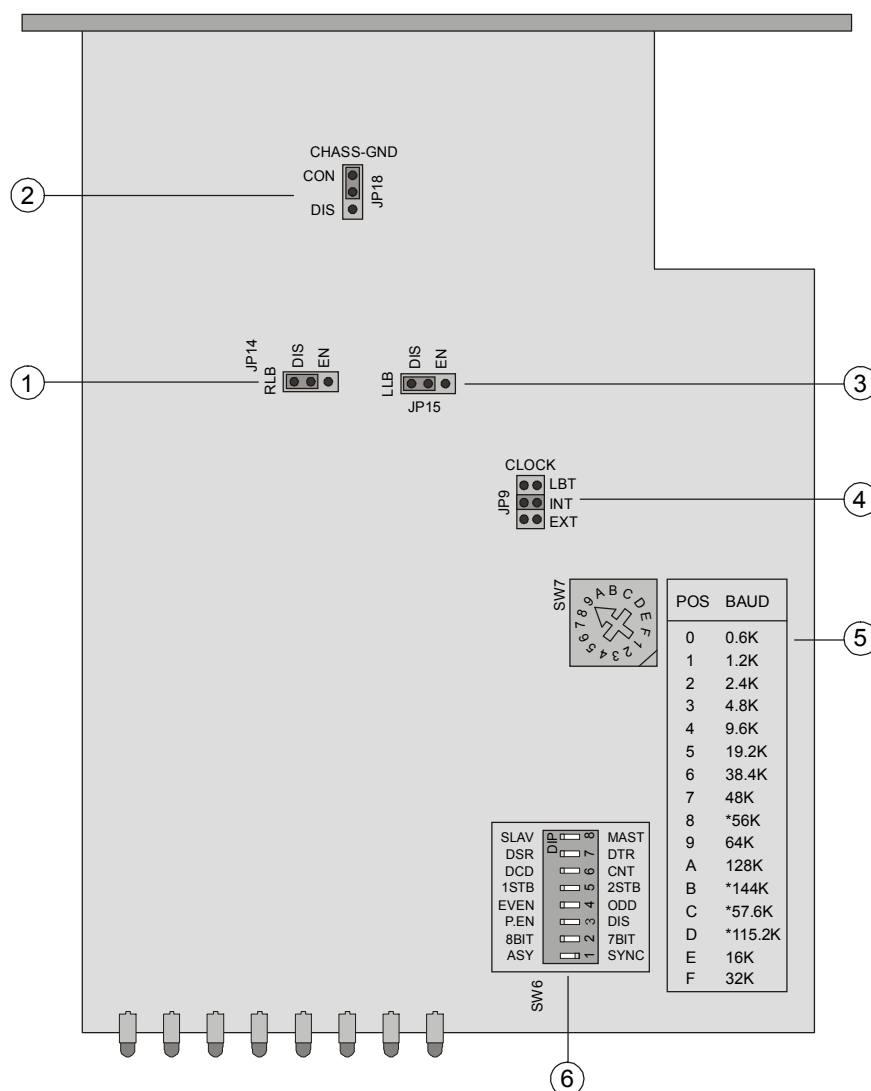
* Baud rates not applicable.

Figure 2-1 ASMi-31 PCB Layout

Table 2-1 ASMi-31 Internal Jumpers and Switches

Item	Jumper	Description	Values	Default Setting
1	RLB, JP14	Controls the remote loopback activation from the DTE	**DIS** – The RLB activation from the DTE is disabled **EN** – The RLB activation from the DTE is enabled	DIS
2	CHASS-GND, JP18	Controls the connection between the ASMi-31 signal ground and the frame (chassis) ground	**CON** – Signal ground is connected to the frame ground **DIS** – Signal ground is disconnected from the frame ground	CON

Note: *Disconnecting the signal ground from the frame ground may render the unit unsafe for connection to unprotected telecommunication networks in some locations.*

Table 2-1 ASMi-31 Internal Jumpers and Switches (Cont.)

Item	Jumper	Description	Values	Default Setting
3	LLB, JP15	Controls the local loopback activation from the DTE	**DIS** – The LLB activation from the DTE is disabled	DIS
			EN – The LLB activation from the DTE is enabled	
4	CLOCK	Controls the ASMi-31 timing reference	**LBT** – Loopback timing, clock is recovered from the data at the line side	LBT
			INT – Internal clock	
			EXT – External clock	
5	SW7	Selects the data rate	**1** – 1.2 kbps, sync/async	
			2 – 2.4 kbps, sync/async	
			3 – 4.8 kbps, sync/async	
			4 – 9.6 kbps, sync/async	
			5 – 19.2 kbps, sync/async	
			6 – 38.4 kbps, sync/async	
			7 – 48 kbps, sync	
			9 – 64 kbps, sync	9 – 64 kbps
			A – 128 kbps, sync	
			E – 16 kbps, sync	
			F – 32 kbps, sync	
5	SW6	DIP switch, which consists of eight section		
	Section 1	Controls the ASMi-31 operation mode – synchronous or asynchronous	**ON** – Async operation	
			OFF – Sync operation	Sync
	Section 2	Defines the number of data bits to be used	**ON** – 8 bits	8 bits
			OFF – 7 bits	
	Section 3	Controls the use of parity	**ON** – Parity enabled	P.EN
			OFF – Parity disabled	
	Section 4	Defines the parity type	**ON** – Even parity	Even
			OFF – Odd parity	
	Section 5	Defines the number of stop bits	**ON** – One stop bit	1STB
			OFF – Two stop bits	
	Section 6	Controls the RTS to DCD transfer	**ON** – DCD, the DCD signal turns on when the two units reach synchronization	DCD
			OFF – CNT, the DCD signal of the local unit follows the RTS signal of the remote unit	

Note: *The DCD signal is OFF when a digital loopback is active (receiving RLB command) or when there is no synchronization between the units).*

Table 2-1 ASMi-31 Internal Jumpers and Switches (Cont.)

Item	Jumper	Description	Values	Default Setting
	Section 7	Controls the DTR to DSR transfer	**ON** – Indicates only that the local unit is powered up. It does not indicate the status of the communication channel or operational status of the remote site	DSR
			OFF – Indicates that the DSR of the local unit follows the DTR signal of the remote unit	
	Section 8	Controls the ASMi-31 operational status – slave or master	**ON** – Slave	Slave
			OFF – Master	

Closing the ASMi-31 Case

After completing the internal settings, close the unit case.

➤ **To close the ASMi-31 case:**

1. Replace the upper half of the unit and press firmly until the plastic tabs fit into the tab housing.

2. Insert the original cover screws in their positions and tighten carefully. Do not use excessive torque.

Connecting the Interfaces

Figure 2-2 illustrates the rear panel of the ASMi-31 modem.
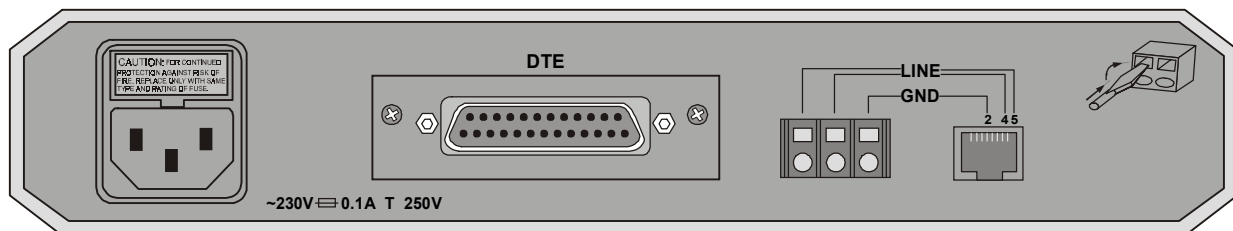
Figure 2-2 ASMi-31 Rear Panel

Connecting the Line

The ASMi-31 line connector is a terminal block/RJ-45 connector. Connect the transmission line (twisted pair) to the two clips marked LINE and the cable shield to the clip marked GND (optional). High rate data communication twisted pair cable is highly recommended in order to prevent crosstalk.

Before connecting the cables, make sure that the equipment is earthed by its power cable.

Caution   Insert the GND lead first.

➤ **To connect the line:**

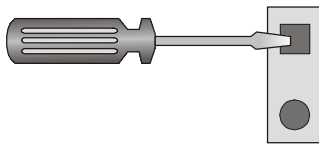1. Insert the screwdriver into a square hole (see *Figure 2-3*).

Figure 2-3 Connecting the Line – Step 1

2. Raise the inserted screwdriver, putting pressure on the ramp within the square hole (see *Figure 2-4*).
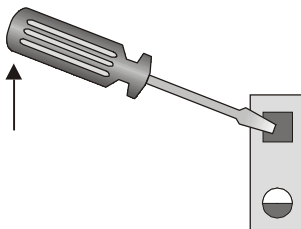

Figure 2-4 Connecting the Line – Step 2

3. Insert the stripped end of the wire and remove the screwdriver (see *Figure 2-5*).
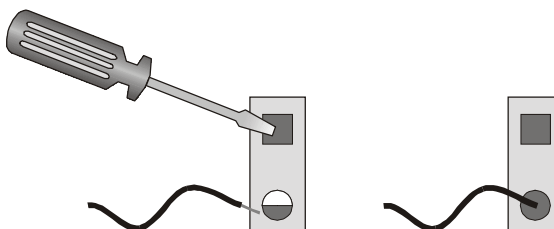
Figure 2-5 Connecting the Line – Step 3

Connecting the DTE

The rear-panel DTE connector provides interface for data input/output, clock reference and control signal exchange between ASMi-31 and the DTE. The DTE interface is changeable module with the interface connector. The DTE is connected to ASMi-31 via adapter cables depending on the interface type, see *Table 2-2* to select the correct cable for your DTE interface.

Table 2-2 DTE Interfaces and Matching Adapter Cables

DTE Interface	Connector Description	RAD Cable
V.24/RS-232	25-pin, D-type, female	CBL-HBT/V24
V.35	34-pin, female	CBL-HBT/V35
X.21	15-pin, female	CBL-HBT/X21

Table 2-2 DTE Interfaces and Matching Adapter Cables (Cont.)

DTE Interface	Connector Description	RAD Cable
RS-530/RS-449	25-pin, D-type connector. For a description of the cabling connection between the RS-530 interface and the RS-449/RS-442 (V.36) 37-pin, D-type connector, see *Appendix E*. The cable is provided with the product.	CBL-HBT/RS-530
G.703	Codirectional 64 kbps interface. For a description of the G.703, see *Appendix B*.	
Ethernet Interface	RJ-45 or BNC connector. For a description of the Ethernet interface, see *Appendix A*.	

Connecting the Power

The AC power is supplied to the ASMi-31 unit through the 1.5m (5 ft) standard power cable terminated in a standard 3-prong plug (see *Figure 2-2*). The cable is provided with the unit.

The rated fuse for the unit is 250V / 0.1A slow-blow for 230V, or 250V / 0.2A slow-blow for 115V.

⚠ *Warning*

The unit has no power switch. Operation starts when the power is applied to the rear-panel POWER connector.

Before switching on this instrument, the protective earth terminals of this instrument must be connected to the protective ground conductor of the power cord. The power plug shall only be inserted in a power outlet provided with a protective earth contact. The protective action must not be negated by use of an extension cord (power cable) without a protective conductor (grounding).

Make sure that only fuses with the required rated current, as marked on the ASMi-31 rear panel, are used for replacement. The use of repaired fuses and the short-circuiting of the fuse holders is forbidden.

Whenever it is likely that the protection offered by fuses has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

➤ **To connect AC power to ASMi-31:**

1. Connect the power cable to the connector on the ASMi-31 rear panel.

2. Connect the power cable to the mains outlet.

    The unit will be turned on automatically upon connection to the mains.

➤ **To connect DC power to ASMi-31:**

● Refer to *DC Power Connection Supplement*.

Chapter 3

Operation

This chapter provides the following information for the ASMi-31 standalone modem:

- ASMi-31 front-panel indicators and controls

- Operating procedures (turn-on, front-panel indications, performance monitoring and turn-off).

Installation procedures given in *Chapter 2* must be completed and checked before attempting to operate ASMi-31.

3.1 Controls and Indicators

Figure 3-1 illustrates the ASMi-31 standalone modem front panel. *Table 3-1* lists the functions of the controls and indicators.
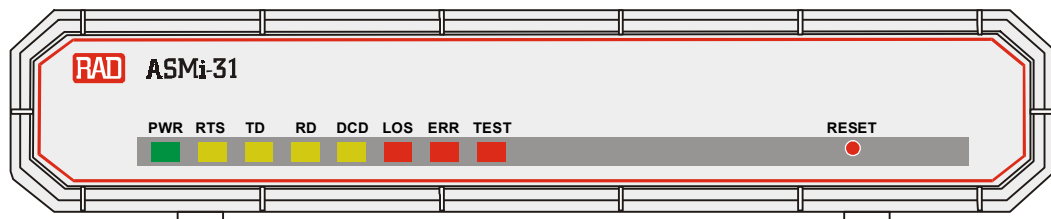

Figure 3-1 ASMi-31 Front Panel

Note *In ASMi-31 modem/X.21 RTS LED is equivalent to Control signal (C), and DCD LED is equivalent to Indication signal (I).*

Table 3-1 Front Panel Controls and Indicators

Name	Type	ITU Circuit	Function
RESET	Button		This switch resets the unit; it is used in place of a power switch. It is not needed for normal operation.
PWR	Green LED		On when ASMi-31 is powered up.
RTS	Yellow LED	105	On when the DTE has emitted an active Request to Send signal (or Control in X.21).
TD	Yellow LED	103	On when a steady space is being transmitted. Blinks when data is transmitted.
RD	Yellow LED	104	On when a steady space is being received. Blinks when data is received.

Table 3-1 Front Panel Controls and Indicators (Cont.)

Name	Type	ITU Circuit	Function
DCD	Yellow LED	109	On when the local and remote modems are in sync, and the section 6 of the internal SW6 switch is set to ON.
			On when the local and remote modems are in sync, and the section 6 of the internal SW6 switch is set to OFF, and the RTS at the remote modem is ON.
LOS	Red LED		On when loss of synchronization occurs between the local and remote modem.
ERR	Red LED		On when an error occurs in the configuration received from the master unit.
TEST	Red LED		On when a test is active.

3.2 Operating Instructions

Turning ASMi-31 On

ASMi-31 turns on as soon as power is connected. When power is connected, the PWR indicator lights up and remains lit as long as ASMi-31 receives power.

Normal LEDs Indications

Check that the other front panel LEDs appear as listed in *Table 3-2*. This indicates that the local and remote ASMi-31 units are operational and passing data.

Table 3-2 ASMi-31 Controls and Indicators – Normal Operation

Name	State	Function
PWR	On	
TD	On or blinking	Flashing depends upon the data being transmitted.
RD	Off or blinking	Flashing depends upon the data being received.
RTS		Lights when RTS status is On
DCD		Lights when RTS is received from the remote modem and the modems are synchronized (DCD - OFF - switch SW6)
LOS	On or blinking	Blinks until synchronization between the modems is achieved. Constantly On when there is no synchronization.
ERR	Off or blinking	Blinks until synchronization between the modems is achieved.
TEST	On or blinking	Blinks until synchronization between the modems is achieved. Constantly On while test is activated from either local or remote unit.

If the above LED indicators are not obtained following initial power-up, make sure that:

- One modem is set to internal or external clock, and the other to LBT clock.

- None of the modems are in test mode.

Turning ASMi-31 Off

To turn off ASMi-31, simply remove the power cord from the power source.

Chapter 4

Troubleshooting and Diagnostics

This chapter describes how to perform diagnostics tests on ASMi-31.

The function of diagnostic tests on ASMi-31 is to:

- Check that the system is operating normally

- Isolate faulty equipment or cables

- Identify other sources of system malfunction.

Tests are activated via the corresponding DTE pins and monitored via the ASMi-31 front-panel LED indicators.

4.1 Diagnostic Tests

The diagnostic capabilities of the ASMi-31 modem allow rapid checkout of the DTEs, the ASMi-31 modem, and connecting lines. The test will immediately verify the operational performance of each unit in the system or provide an indication of equipment failure.

Before testing the operation of the data system equipment and 2-wire line circuits, first ensure that all units are powered on and configured normally, then perform the test steps described below, in order.

ASMi-31 supports two types of loopback tests for evaluating the operation of the data system equipment and line circuits. Using these loopbacks, you can test the communication between the attached equipment, internal circuitry of the local ASMi-31 and the remote ASMi-31.

Local Analog Loopback (LLB)

The Local Analog Loopback (LLB) test checks the performance of the local ASMi-31, the local DTE, and the connections between them (see *Figure 4-1*). Perform the test separately at the local and the remote site.
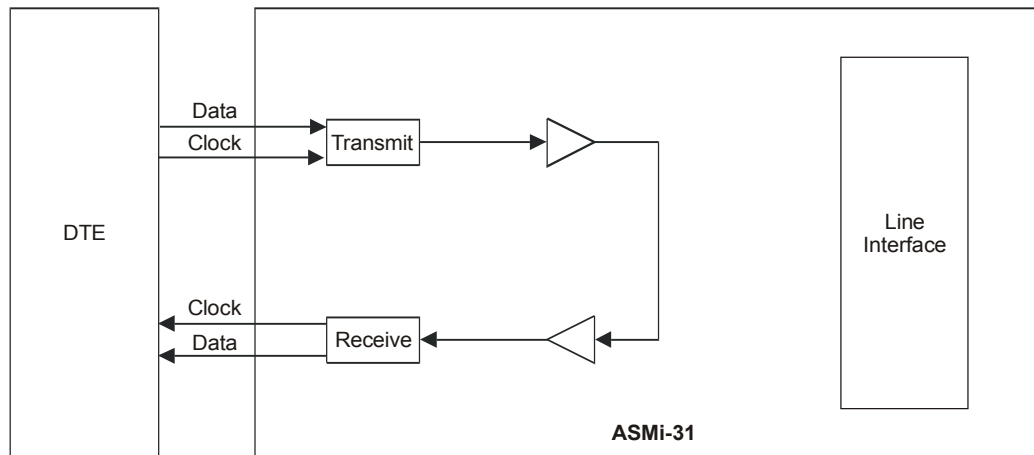

Figure 4-1　Local Analog Loopback

➤ **To perform the Local Analog Loopback test:**

● Activate the test via the DTE interface analog loopback.

　　The TEST LED lights up.

The ASMi-31 modem transmit output is connected to the receiver circuits internally at the line side. If a fault is indicated, call a technician or replace the unit.

Set the DTE equipment in half duplex (which produces an "echo" through the system). It is recommended that you repeat the LLB test using an external Bit Error Rate Tester (BERT).

Perform the test at both ends. If the BERT equipment test indicates no faults, but the data terminal indicates a fault, follow the DTE manufacturer's test procedures . Also check the interconnecting cable interfacing between the terminal and the ASMi-31 modem.

After completing the test (or when the fault has been corrected), deactivate the LLB via the DTE interface and proceed to the Remote Loopback (Communication Link) Test.

Remote Loopback (RLB)

This test determines the performance of both the local and the remote ASMi-31 modems, as well their connecting 2-wire line between them. The test activates a diagnostic loopback at the remote ASMi-31 modem (see *Figure 4-2*).
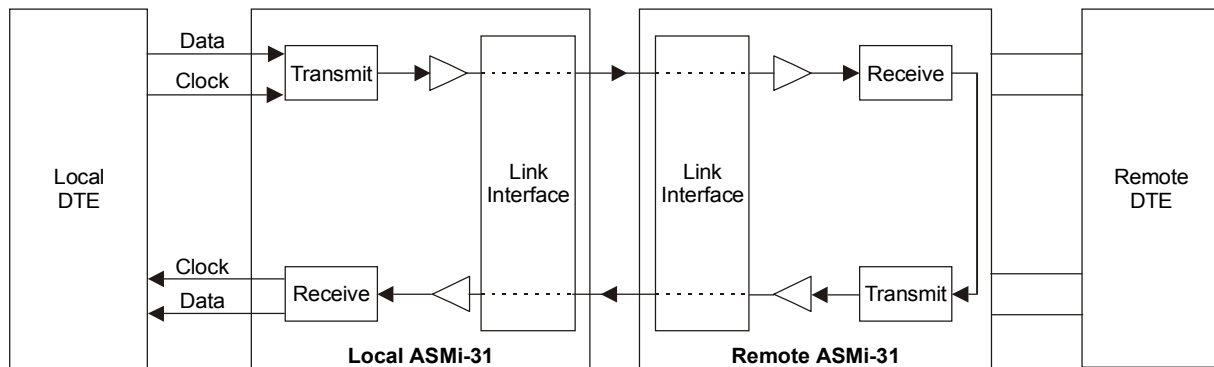

Figure 4-2 Remote Digital Loopback

➤ **To activate the Remote Digital Loopback:**

- Activate the Remote Loopback via the DTE interface.

   The TEST LED lights on both units.

Set the DTE equipment in half duplex (which produces an "echo" through the system), or run a Bit Error Rate test.

Perform the test at both ends. If the BER test indicates a fault and if the LLB test was successful for both local and remote modems, then the 2-wire line circuits inside the modem are not operating properly, or the line connection between the modems is faulty.

Chapter 5
Card Cage Version

This chapter describes the ASMi-31/R card version, designed for installation in the ASM-MN-214 card cage. The chapter contains the following sections:

• Section 5.1 describes the ASM-MN-214 card cage

• Section 5.2 describes the ASMi-31/R card version

• Section 5.3 describes the power supply to ASMi-31/R

• Section 5.4 describes how to install ASMi-31/R.

5.1 ASM-MN-214 Card Cage

The ASM-MN-214 card cage contains one or two power supplies and up to 14 plug-in cards. The card types can be ASMi-31/R or other RAD rack version modems/converters - any combination of up to 14 plug-in cards.

For each of the 14 cards, the rear panel (see *Figure 5-1*) contains a male connector for the terminal block and a DB-25 connector. A protection cover protects the terminal block connectors.

The terminal block (see *Figure 5-1*) is to be attached to the rear panel terminal block connectors. It contains screws for connecting the transmit and receive pairs and ground, if present.

The 25-pin D-type female interface connector provides all interface signals for the digital interfaces. Modems with X.21 or V.35 interface require an external mechanical adapter.

Two optional interface attachments, CIA/V.35/1 and CIA/X.21, can be ordered separately from RAD. CIA/X.21 converts two adjacent DB-25 connectors to two X.21 15-pin connectors. CIA/V.35/1 converts one DB-25 connector to a V.35 34-pin connector.

V.36 modem cards are supplied with a RAD adapter cable CBL 530/449F, which converts the DB-25 connector to a V.36 37-pin connector. The adapter cable and two interface attachments are also shown in *Figure 5-1*.
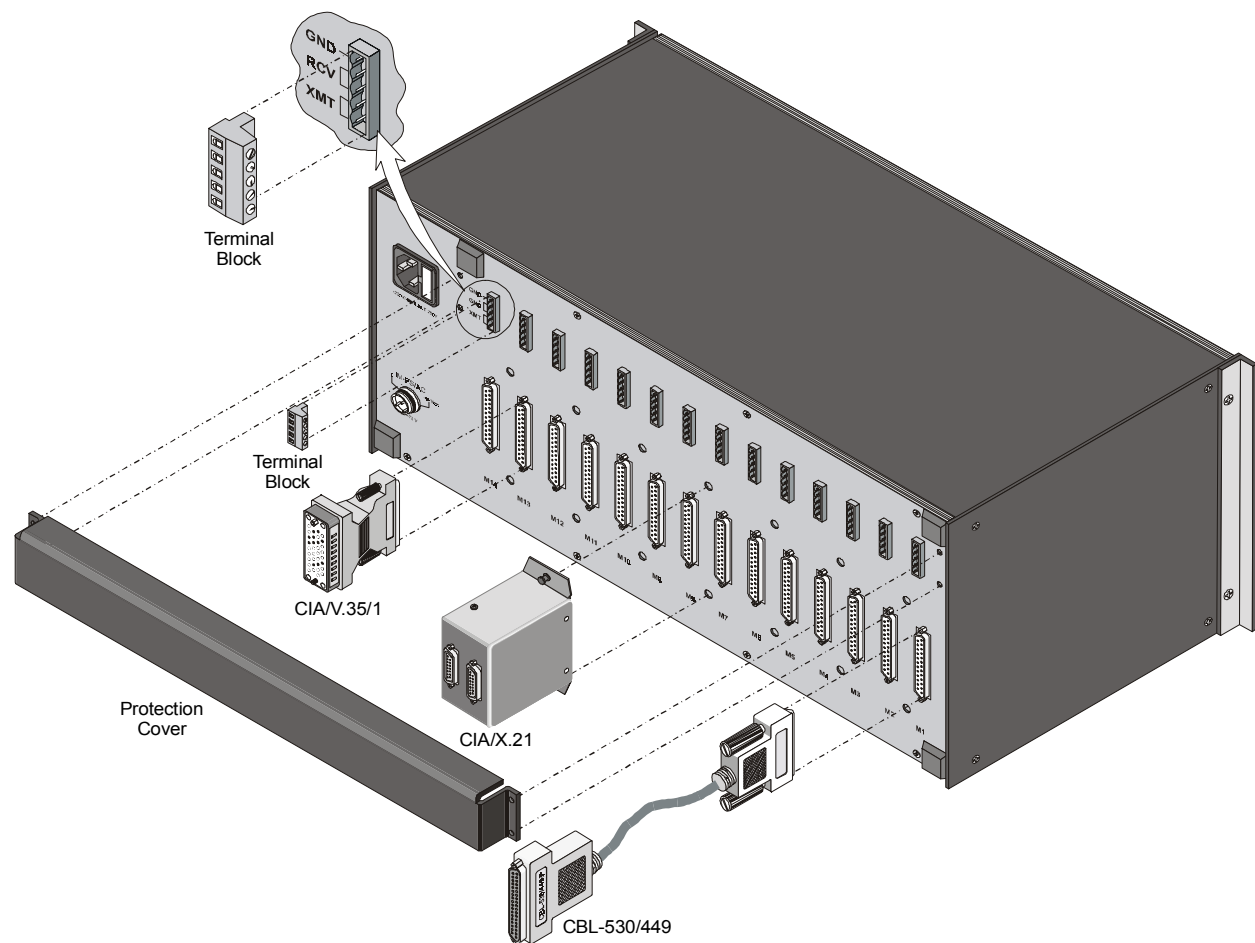
Figure 5-1 ASM-MN-214 Rear Panel

5.2 ASMi-31/R Card Version

Figure 5-2 shows the ASMi-31/R card front panel. The LEDs and switches of the card version are identical in their functionality to those of the standalone device. For this information, refer to *Section 3.1, Controls and Indicators*, in Chapter 3.

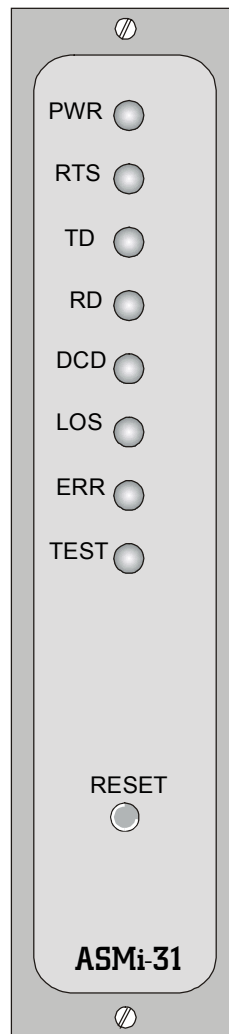The jumper settings are the same as with ASMi-31 standalone version (refer to *Table 2-1)*.

Figure 5-2 ASMi-31/R Front Panel

5.3 Power Supply

Power is supplied to the ASMi-31/R card from the ASM-MN-214 power supply via the chassis. Each ASMi-31/R card has two fuses, which protect the entire system against power failure resulting from a short circuit in one card.

The ASM-MN-214 card cage can accept both AC or DC power supplies. LED indicators located on the ASM-MN-214 front panel (see *Figure 5-3*) show activity when the power supply is connected to the mains plug. The power supply supports the full card cage with any combination of cards.

AC Supply (100, 115 or 230 VAC) The AC power supply of the ASM-MN-214 is 100, 115 or 230 VAC, ±10%, 47 to 63 Hz.

DC Supply (-48 VDC) The DC power supply is - 48 VDC (-36 to -72 VDC). It uses a DC/DC converter module to provide the power required for the cards.

Power Supply with Redundancy This special ordering option is equipped with two separate power supplies, operating together and sharing the load of the whole card cage. If either of the power supplies fails, the other one will continue to supply power to the full card cage.

Two LED indicators show activity of each power supply. They should both light when mains power is provided.

Note *It is possible to combine AC and DC power supplies in the same cage.*

Figure 5-3 ASM-MN-214 Front Panel

5.4 Installing ASMi-31/R

➤ **To install the ASMi-31/R card in the ASM-MN-214 card cage:**

1.   Install the ASM-MN-214 card cage in the 19" rack.

2.   Adjust the jumpers and switches on the card as required (see *Figure 2-1* and *Table 2-1* in Chapter 2).

3.   Insert the ASMi-31/R card into one of the ASM-MN-214 slots. Push the bottom of the card into the cage to until it is fully inserted into the edge connector inside the rack. Tighten the screws on the top and on the bottom of each card.

4.   Remove the protection cover from the terminal block connectors.

5.   Connect the terminal block to the ASM-MN-214 terminal block connector.

6.   Connect the line to the terminal block as follows: connect transmit pair to the terminals marked XMT, the receive pair to the terminals marked RCV, and the fifth screw to ground (optional).

7.   If required, attach the appropriate CIA (CIA/X.21 or CIA/V.35/1) or V.36 adapter cable to the DB-25 connector on the card cage rear panel.

8.   Connect the DTE cable to the DB-25 connector, other side of CIA or adapter cable (depending on your version of the card interface).

9.   Connect power to the ASM-MN-214 card cage:

   • To connect AC power, connect the power cable to the mains supply.

   • To connect DC power, refer to *DC Power Supply Connection Supplement* of the ASM-MN-214 manual.

⚠️
Warning

The ASM-MN-214 card cage has no power switch. Operation starts when the power is applied to the rear panel POWER connector. When applying power, first connect the plug of the power cord to the ASM-MN-214 POWER connector and then to the mains power source (outlet).

Appendix A
Ethernet Interface

A.1 General

This appendix:

- Describes the IR-ETH for RAD modems

- Describes the different IR-ETH connector options

- Lists the Ethernet bridge specifications

- Explains how to install and operate an Ethernet bridge.

A.2 Description

The IR-ETH is an interface module for RAD modems, used for converting the Ethernet (10BaseT or 10Base2) electrical levels to the modem TTL levels. It also converts the Ethernet protocol to HDLC to enable long distance transmission and avoid the Ethernet collision limitation.

The IR-ETH includes an internal, self-learning Ethernet bridge, which enables a high performance link between two Ethernet segments at a low transmission rate. The low-speed HDLC transmission is sent over the link using the modem modulation technique. It is converted back to an Ethernet signal at the remote modem.

Figure A-1 shows a typical application using an Ethernet interface bridge. Each modem is connected to an Ethernet network via the Ethernet Interface bridge.
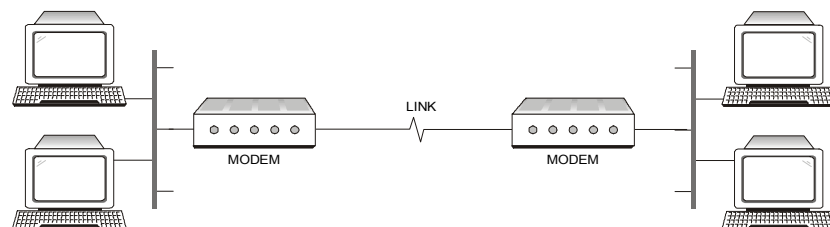

Figure A-1 Ethernet Interface Typical Application

A.3 IR-ETH Connector Options

Figure A-2 and *Figure A-3* show the rear panel of ASMi-31 with the IR-ETH connector options. The IR-ETH connector for the ASMi-31/R card (rack mount version) is shown in *Figure A-4*.
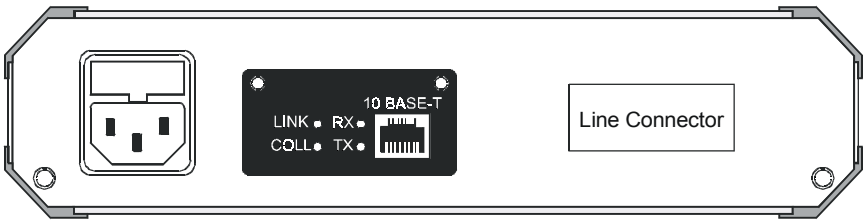

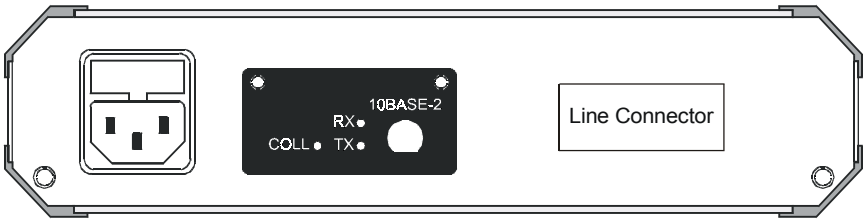*Figure A-2 ASMi-31 Rear Panel with IR-ETH/UTP Connector Option*

Figure A-3 ASMi-31 Rear Panel with IR-ETH/BNC Connector Option
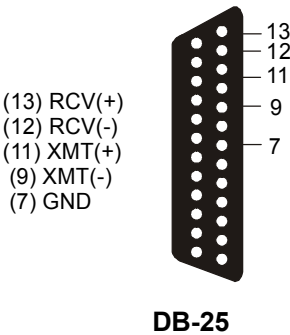

DB-25

Figure A-4 IR-ETH Connector for the ASMi-31/R Modem Card

When using the RJ-45 connector, the customer must prepare a mechanical cable for adapting the DB-25 pinout to that of RJ-45. The pinouts of the DB-25 and RJ-45 connectors are given in *Table A-1*.

Table A-1 DB-25 and RJ-45 Pin Assignment for IR-ETH Connection

Signal	Pin	
	DB-25	**RJ-45**
RCV (+)	13	3
RCV (-)	12	6
XMT (+)	11	1
XMT (-)	9	2
GND	7	-

A.4 Ethernet Bridge Specifications

General
LAN Table	10,000 addresses
Filtering and Forwarding	15,000 pps
Buffer	256 frames
Delay	1 frame

LAN
Standard	Conforms to IEEE 802.3/Ethernet
Data Rate	10 Mbps (20 Mbps 10BaseT FDX)
Connectors	10BaseT (UTP): Shielded RJ-45 10Base2: BNC connector

WAN
Protocol	HDLC
Data Rate	According to the modem transmission rate

A.5 Installation and Operation

Figure A-5 and *Figure A-6* show the Ethernet bridge layout, the locations of the DIP switches, and the rear panel components for the UTP and the BNC versions, respectively.
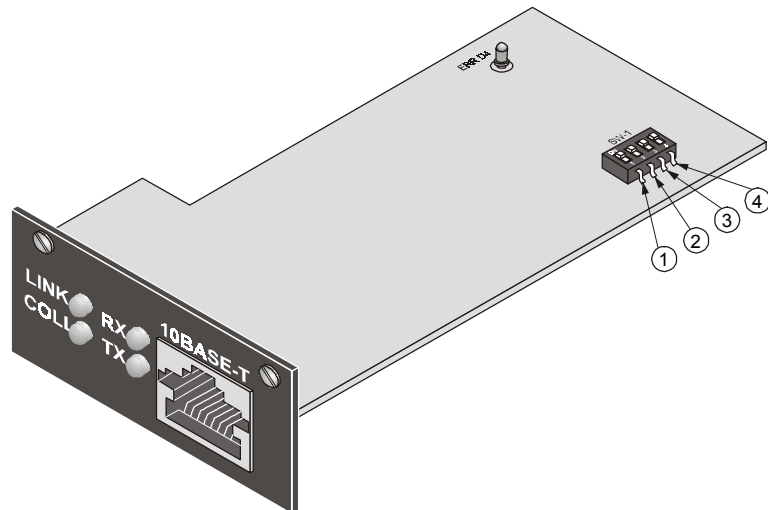

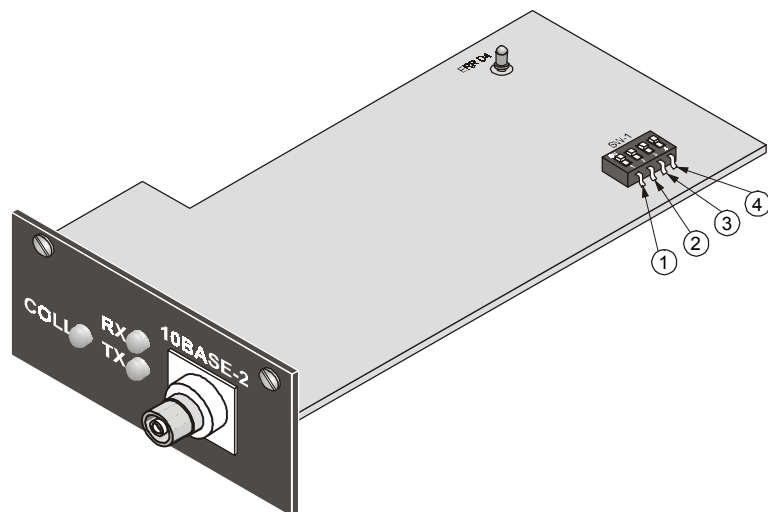*Figure A-5 Ethernet Bridge Layout (UTP Option)*

Figure A-6 Ethernet Bridge Layout (BNC Option)

LAN Installation

For 10BaseT installation, either a straight cable or a cross-cable may be required. Use a cross-cable when connecting to a port that does not implement the crossover function internally. Otherwise, use a straight cable.

Note   *Hubs usually implement the crossover function internally while NICs and other devices do not.*

Switch Settings

Set switches according to *Table A-2*.

Table A-2 DIP Switches Settings

Switch Number	Name	Description	Default Setting
1	SQ/FD	ON: Ethernet full-duplex mode OFF: Ethernet half-duplex mode	OFF
2	CMP	ON: Strips padding bits inserted in 64-byte frame OFF: Transmits frames over WAN as is	ON
3	FIL	ON: Passes only frames destined for another LAN OFF: Disables LAN filter; passes all frames transparently	ON
4	(nc)		OFF

Note   *The SQ/FD switch is not used in the Ethernet bridge with the BNC connector option.*

LED Indicators

Table A-3 lists the IR-ETH LED indicators and describes their functions.

Table A-3 IR-ETH Bridge LED Indicators

LED Name	Description	Location	Color
LINK	ON indicates good link integrity (available only in the 10BaseT version)	Panel	Green
COLL	ON indicates collision on the attached Ethernet segment	Panel	Yellow
RX	ON when data is received from the Ethernet attached segment	Panel	Yellow
TX	ON when data is transmitted from the modem to the Ethernet segment	Panel	Yellow
ERR D4	Bridge buffer overrun	On board	Red

Appendix B

IR-G.703 Codirectional Interface (64 kbps)

B.1 Introduction

This appendix:

- Provides a general description of the IR-G.703 Codirectional interface (64 kbps)

- Describes the EXT mode for the IR-G.703 Codirectional interface (64 kbps)

- Describes the INT/RCV mode for the IR-G.703 Codirectional interface (64 kbps).

B.2 General Description

The IR-G.703 is an interface module for RAD modems, converting G.703 Codirectional signals to TTL levels. The converted data is sent over the modem link using the modem modulation technique and converted back at the other end into G.703 64 kbps Codirectional signals, or into any other digital interface signal possible. The module is available in the following two versions:

- **The Standalone version** fits into a standalone modem and is available with two types of physical connections: a terminal block or an RJ-45.

- **The Rack version** is mounted on the rack version modem card and uses the modem edge connector for communication. The edge connector is wired, on the motherboard of the card cage, to the DB-25 connector on the back plane of the ASM-MN-214 card cage. *Figure B-1* illustrates the pinout of the different connectors.
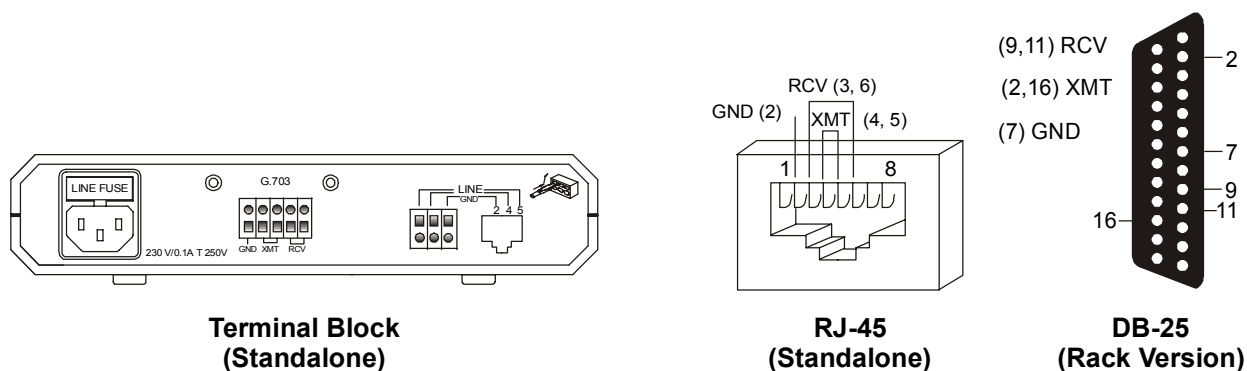
Figure B-1 IR-G.703 Connector Options

Note   *In Figure B-1, RCV refers to the input signals to the interface module; XMT refers to the output signals from the module.*

The IR-G.703 interface module is shown in *Figure B-2*. It has two operation modes which are selectable on the PCB board. The selection is made by means of the JP1 jumper located within the module as shown in *Figure B-2*. The EXT mode is described in *EXT Mode* below and illustrated by *Figure B-3*. The INT/RCV mode is described in *INT/RCV Mode* below and illustrated by *Figure B-4*.

Note   *The IR-G.703 interface should be in accordance with the modem clock mode. For example, if the modem is in the EXT mode, then JP1 should be set to the EXT position.*
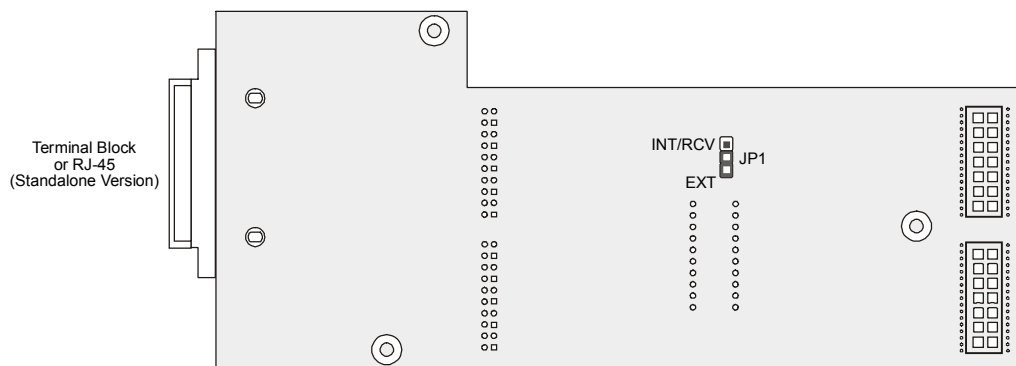
Figure B-2 Location of JP1 on the IR-G.703 Interface Module

B.3 EXT Mode

This mode is used in applications, where the system timing is provided by the G.703 network. The IR-G.703 module has an internal buffer to compensate for the phase delay introduced to the system by the line delay between the two modems. The buffer is an 8-bit FIFO connected as shown in *Figure B-3*.

This mode corresponds to the modem clock working in the EXT mode.

Modem A   **Modem B**
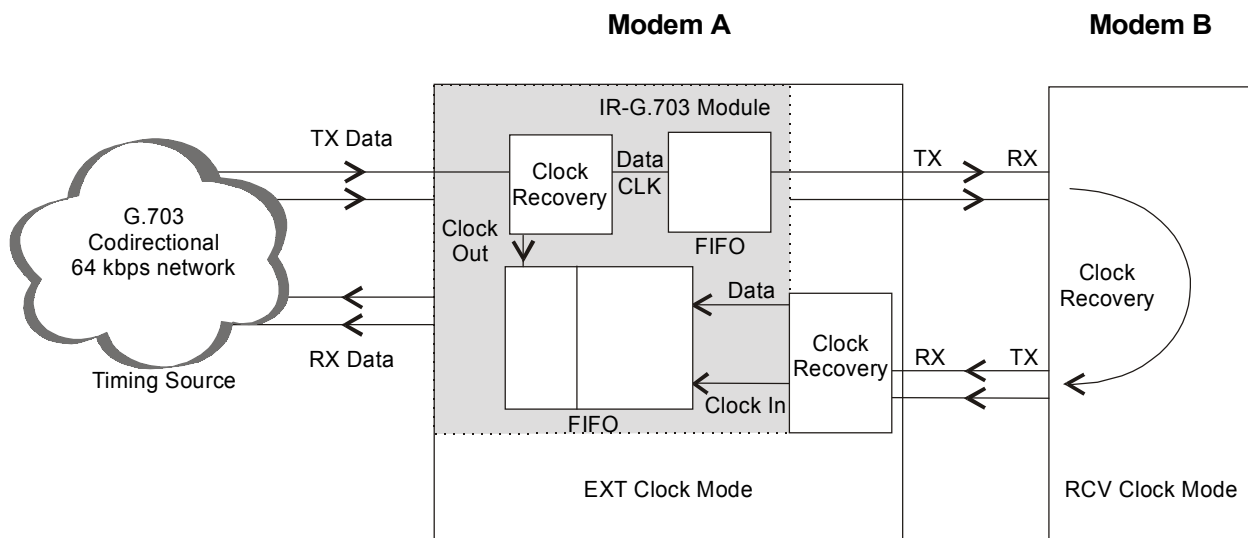
Figure B-3 IR-G.703 EXT Mode Timing Block

B.4 INT/RCV Mode

This mode is used in applications where the G.703 Codirectional 64 kbps equipment connected to the modem recovers the clock signal from the modem link. This mode is used mainly when the attached equipment has a G.703 Codirectional interface, but is not able to produce clock signals. The module has a 8-bit FIFO buffer to compensate for the phase delay introduced by the G.703 device. *Figure B-4* illustrates the buffer connection and the required application setup.

This mode corresponds to the modem clock working in the INT or RCV mode.

Modem A   **Modem B**

Figure B-4 IR-G.703 INT/RCV Mode Timing Block

Appendix C
X.21 Interface Module

C.1 General

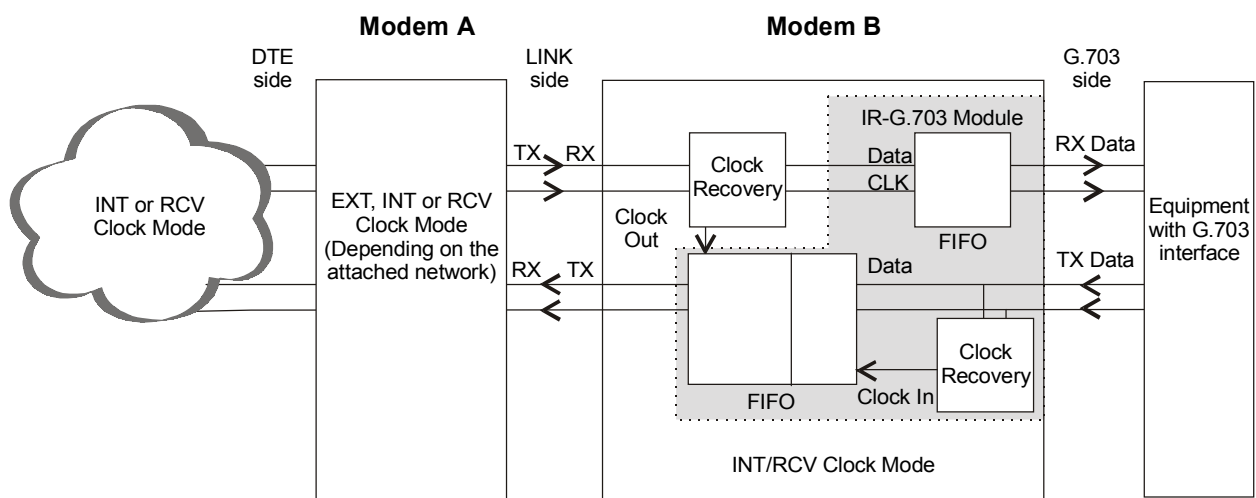IR-X.21 is an interface module for RAD modems, converting X.21 signals to TTL levels. The converted data is sent over the modem link, using the modem modulation technique, and is converted back at the other end into X.21 signals, or into any other digital interface signal.

ASMi-31 is generally supplied with IR-X.21. This is due to an internal FIFO that assumes the phase mismatch when the clock is supplied by an external source. ASMi-31 also has the option to order IR-X.21 for extra buffers.

Figure C-1 shows a typical application of the ASMi-31 standalone modem with the IR-X.21 interface module.
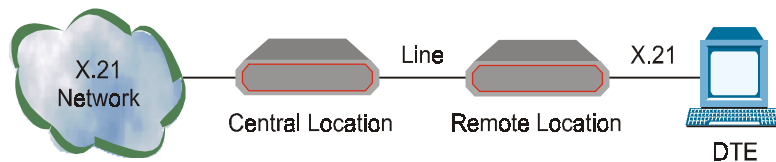
Figure C-1 Typical ASMi-31 X.21 Application

C.2 X.21 Connectors

Figure C-2 shows the rear panel of a standalone ASMi-31 with the IR-X.21 interface module.
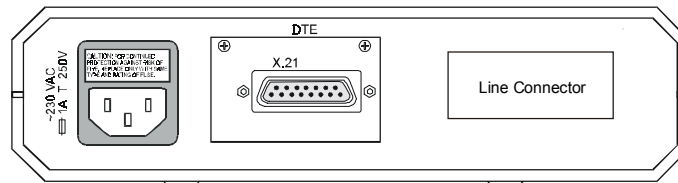
Figure C-2 ASMi-31 Rear Panel with X.21 Connector

The ASMi-31 modem rack version requires an additional adaptor to connect between the DB-15 connector of the X.21 equipment to the DB-25 connector of the ASM-MN-214 modem rack. For this purpose, an optional DB-15 attachment CIA/X.21 can be ordered separately from RAD. The attachment connects to the ASM-MN-214 rear panel as shown for the CIA/V.35 attachment in *Chapter 5*.

Pin Assignment

Table C-1 shows the X.21 DB-15 pin assignment.

Table C-1 IR-X.21 DB-15 (RS-422) Connector Pin Assignment

Pin	ID	Function
1	Shield	Chassis connection
2	A	Transmit signal A
3	A	Control A
4	A	Receive A
5	A	Indication A
6	A	Signal timing A
7	A	External Timing
8	GND	Common
9	B	Transmit B
10	B	Control B
11	B	Receive B
12	B	Indication B
13	B	Signal Timing B
14	B	External Timing
15		Not connected
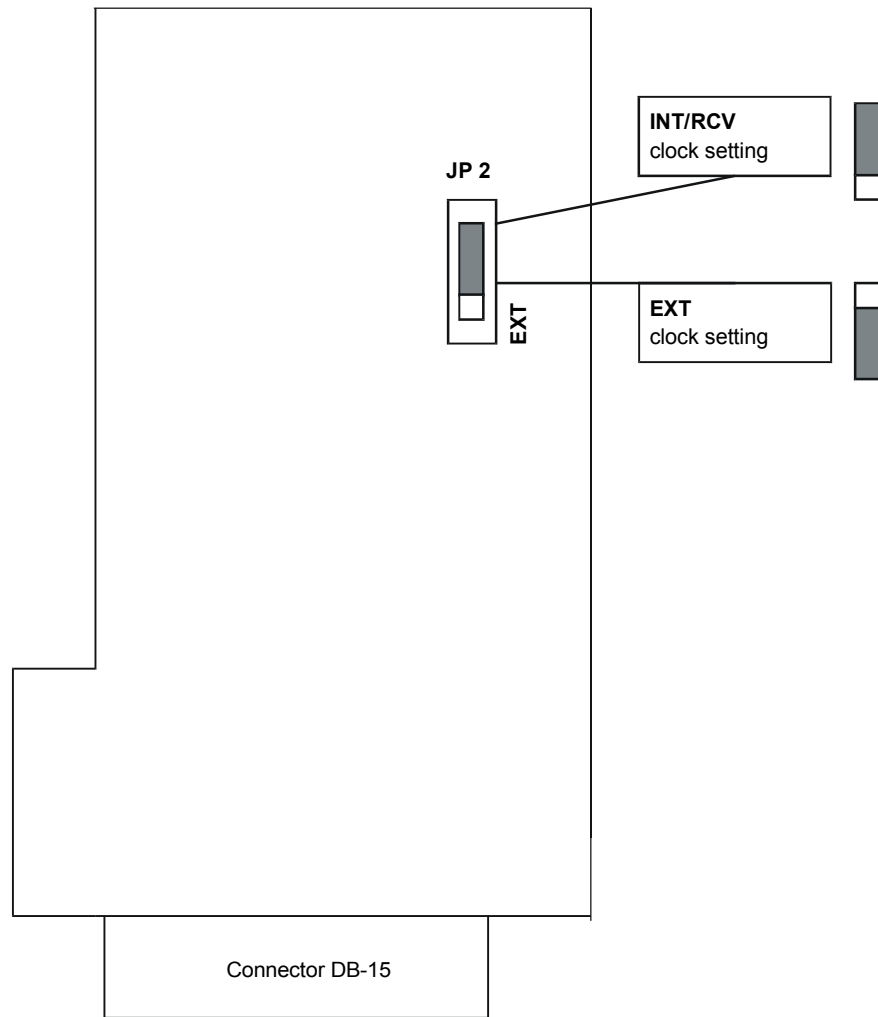
Figure C-3 Location of Jumper JP2 in the IR-X.21 Interface Module

C.3 EXT Mode

This mode is used in applications of X.21 networks where the system timing is provided by the X.21 network. The IR-X.21 module has an internal buffer to compensate for the phase delay introduced to the system by the line delay between the two modems. The buffer is a 16-bit FIFO connected as shown in *Figure C-4*. When the modem's clock mode is EXT, the JP2 jumper must be set to EXT (see *Figure C-3*).
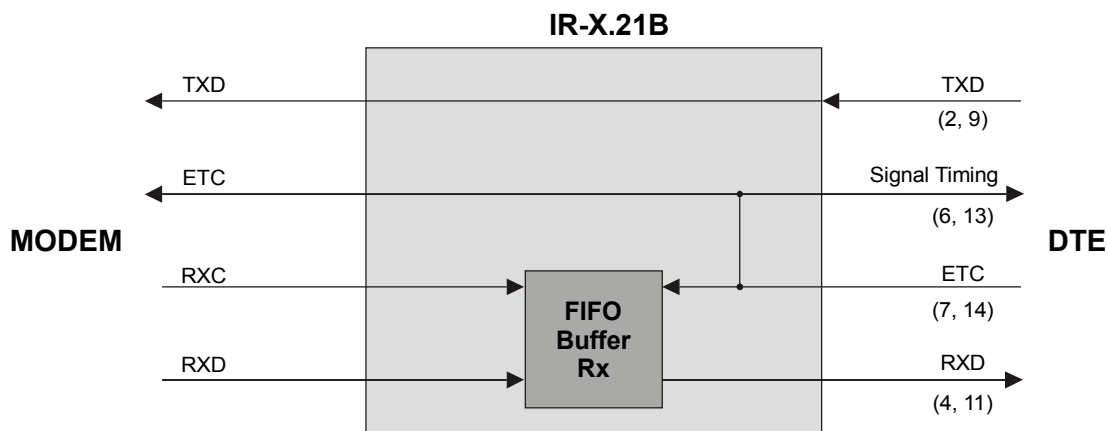
IR-X.21B

Figure C-4 EXT Mode Timing Block

C.4 INT/RCV Mode

This mode is used in applications where the IR-X.21 side uses the clock signal from the modem link. This mode is used mainly when the attached equipment has an IR-X.21 interface, but no ability to produce clock signals. The module has a 16-bit FIFO buffer to compensate for the phase delay introduced by the X.21 device. *Figure C-5* illustrates the buffer connection and the required application setup. When the modem's clock mode is INT or RCV, the JP2 jumper must be set to INT/RCV (see *Figure C-3*).
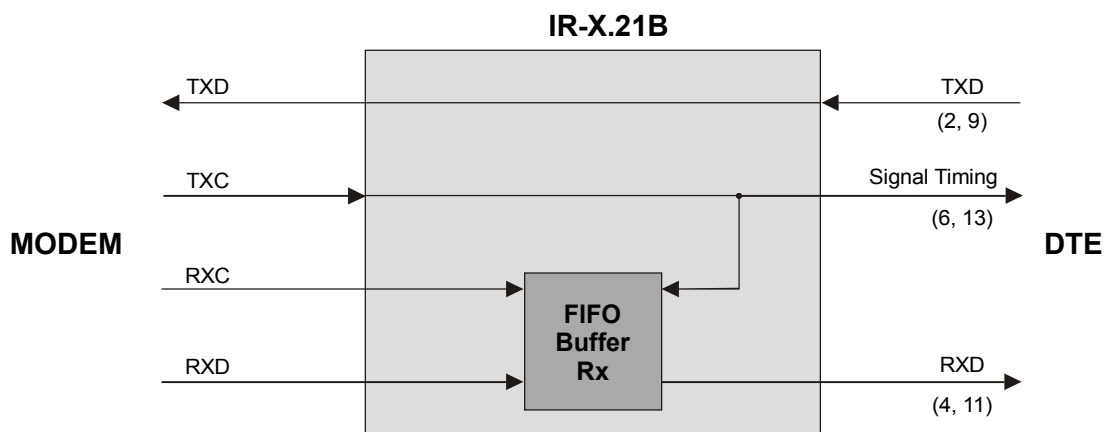
IR-X.21B

Figure C-5 INT/RCV Mode Timing Block

Appendix D
DTE Interface Connectors

D.1 General

Table D-1 provides detailed information about each DTE interface connector.

Table D-1 DTE Interface Signal Assignments

	RS-232	V.35		EIA-530		X.21		
Signal Function	DB-25 Stand-alone and Frame	DB-25 Frame	34-pin Standalone Pin Circuit	DB-25 Standalone and Frame Pin Circuit	DB-25 Frame	DB-15 Standalone Pin Circuit/ (Function)		Description
Protective Ground	1	1	A Frame 101	1	1	1 - [SHIELD]		Chassis ground. May be isolated from Signal Ground. See *Table 2-1*.
Signal Ground	7	7	B Signal 102 Ground	7 AB	7	8 - [GND]		Common Signal and DC power supply ground.
Transmitted Data	2	11 9	S TD(B) 103 P TD(A) 103	2 BA(A) 14 BA(B)	2 14	2 T(A) 9 T(B) [TRANSMIT]		Serial digital data from DTE. The data transitions must occur on the rising edge of the transmit clock.
Received Data	3	12 13	R RD(A) 104 T RD(B) 104	3 BB(A) 16 BB(B)	3 16	4 R(A) 11 R(B) [RECEIVE]		Serial digital data at the output of the modem receiver. The data transitions occur on the rising edge of the receive clock.

Table D-1 DTE Interface Signal Assignments (Cont.)

Signal Function	RS-232 DB-25 Stand-alone and Frame	V.35 DB-25 Frame	V.35 34-pin Standalone Pin Circuit	EIA-530 DB-25 Standalone and Frame Pin Circuit	X.21 DB-25 Frame	X.21 DB-15 Standalone Pin Circuit/ (Function)	Description
Request to Send	4	4	C RTS 105	4 CA(A) 19 CA(B)	4 19	3 C(A) 10 C(B) [CONTROL]	A positive level to ASMi-31 when data transmission is desired.
Clear to Send	5	5	D CTS 106	5 CB(A) 13 CB(B)			A positive level from ASMi-31 with delay, after receipt of Request to Send, and when ASMi-31 is ready to transmit.
Data Set Ready	6	6	E DSR 107	6 CC(A) 22 CC(B)			A positive level from ASMi-31 when the power is on, and ASMi-31 is (a)not in the DIGITAL LOOP mode, or (b) has not received a REMOTE LOOPBACK signal from the remote unit.
Data Terminal Ready	20	20	H DTR 108	20 CD(A) 23 CD(B)			Not used.
Carrier Detect	8	8	F DCD 109	8 CF(A) 10 CF(B)	8 10	5 I(A) 12 I(B) [INDICATION]	A positive level from ASMi-31, except when a loss of the received signal is detected, or when Data Set Ready is negative.

Table D-1 DTE Interface Signal Assignments (Cont.)

	RS-232	V.35		EIA-530		X.21		
Signal Function	DB-25 Stand-alone and Frame	DB-25 Frame	34-pin Standalone Pin Circuit	DB-25 Standalone and Frame Pin Circuit	DB-25 Frame	DB-15 Standalone Pin Circuit/ (Function)		Description
External Transmit Clock	24	19 16	U SCTE(A) 113 W SCTE(B) 113	24 DA(A) 11 DA(B)	24 11	7 (A)* 14 (B)*		A serial data rate clock input from the data source. Positive clock transitions must correspond to data transitions.
Transmit Clock	15	14 10	Y SCT(A) 114 A SCT(B) 114	15 DB(A) 12 DB(B)	15 12	6 S(A) 13 S(B) [SIGNAL TIMING]		A transmit data rate clock for use by an external data source. Positive clock transitions correspond to data transitions.
Receive Clock	17	22 23	X SCR(B) 115 V SCR(A) 115	17 DD(A) 9 DD(B)				A receive data clock output for use by external data sink. Positive clock transitions correspond to data transitions.
Local Analog Loop	18	18	L and j 141	18 LL				A control signal input; when on, commands ASMi-31 into Local Analog Loopback (V.54 Loop 3). See *Table 2-1*.

Table D-1 DTE Interface Signal Assignments (Cont.)

| Signal Function | RS-232 | V.35 | | EIA-530 | X.21 | | |
	DB-25 Stand-alone and Frame	DB-25 Frame	34-pin Standalone Pin Circuit	DB-25 Standalone and Frame Pin Circuit	DB-25 Frame	DB-15 Standalone Pin Circuit/ (Function)	Description
Remote Loopback	21	21	N and h 140	21 RL			A control signal input; when on, commands ASMi-31 to send a remote Loopback command (V.54 Loop 2) to the remote ASMi-31. See *Table 2-1*.
Test Indicator	25	25	n and k 142	25 TM			A control signal output from ASMi-31; positive during any test mode.

Appendix E

Connecting RS-530 to RS-422

Table E-1 Connecting RS-530 to RS-422

Signal Function	RS-449 (RS-422/423)		RS-530	
	37-pin **Pin**	**Circuit**	**DB-25 Female** **Standalone & Card** **Cage Pin**	**Circuit**
Protective Ground	1	Shield	1	
Signal Ground	19	SG	7	AB
DTE Common Return	37	SC		
DCE Common Return	20	RC		
Transmitted Data	4 22	SD (A) SD (B)	2 14	BA (A) BA (B)
Received Data	6 24	RD (A) RD(B)	3 16	BB (A) BB (B)
Request to Send	7 25	RS (A) RS (B)	4 19	CA (A) CA (B)
Clear to Send	9 27	CS (A) CS (B)	5 13	CB (A) CB (B)
Data Set Ready	11 29	DM (A) DM (B)	6 22	CC (A) CC (B)
Carrier Detect	13 31	RR (A) RR (B)	8 10	CF (A) CF (B)
External Transmit Clock	17 35	TT (A) TT (B)	24 11	DA (A) DA (B)

Table E-1 Connecting RS-530 to RS-422 (Cont.)

Signal Function	RS-449 (RS-422/423)		RS-530	
	37-pin Pin	Circuit	DB-25 Female Standalone & Card Cage Pin	Circuit
Transmit Clock (From DCE)	5 23	ST (A) ST (B)	15 12	DB (A) DB (B)
Receive Clock (From DCE)	8 26	RT (A) RT (B)	17 9	DD (A) DD (B)
Local Analog Loopback	10	LL	18	LL
Remote Loopback	14	RL	21	RL
Test Indicator	18	TM	25	TM

Appendix F

Installation in 19" Rack

F.1 Installation of the ASMi-31 Unit in 19" Rack

General

The height of the unit is 1U (1.75"); the width of the unit is slightly less than half the available mounting width. A rack adapter kit, RM-9, is available for installing either a single unit or two units side by side in the 19" rack.

⚠
Warning

Disconnect the power before performing the procedures below. Installation, operation, and maintenance of this unit should only be performed by an experienced technician.

Installation of a Single Unit

Rack adapter components for installing a single unit include one short bracket and one long bracket.

➤ **To install a single unit:**

1. Fasten each bracket to the side walls of the unit by two screws which are inserted into the two front holes on the side wall. (The unit is supplied with nuts already in place on the inner side wall). Note that the short bracket fastens to the left side of the unit, and the long bracket to the right side of the unit (see *Figure F-1*).

   Once the brackets are fastened to the side walls, the unit is ready for installation in the 19" rack.

2. Place the unit in the rack and fasten the brackets to the side rails of the rack using two screws on each side (not included in the kit).
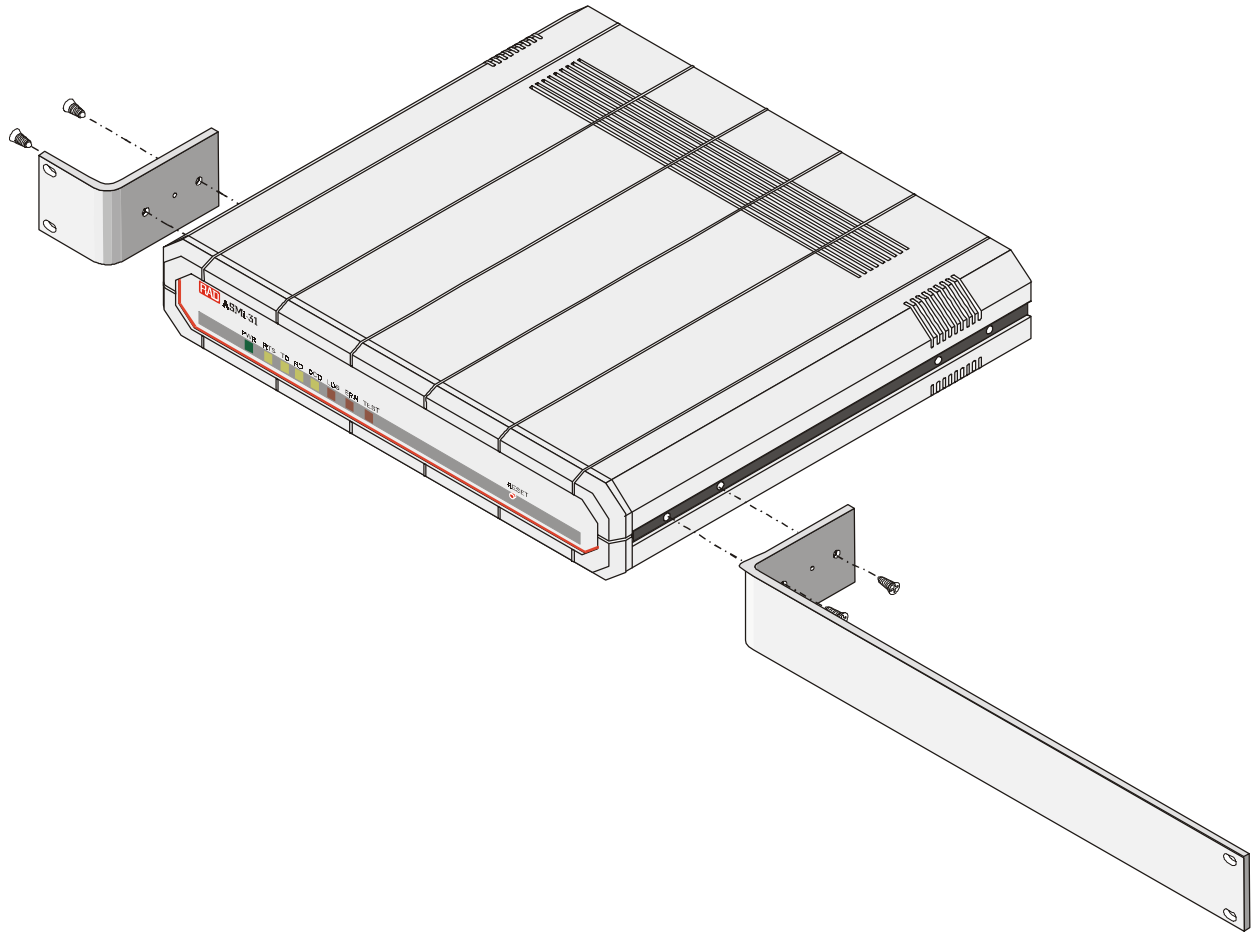
Figure F-1 Installation of a Single Unit

Installation of Two Units

Rack adapter components for installing two units include two long side rails (one for each unit) which slide one into the other, fastening the two units together and two short side brackets which hold the two units in the 19" rack (see *Figure F-2*).
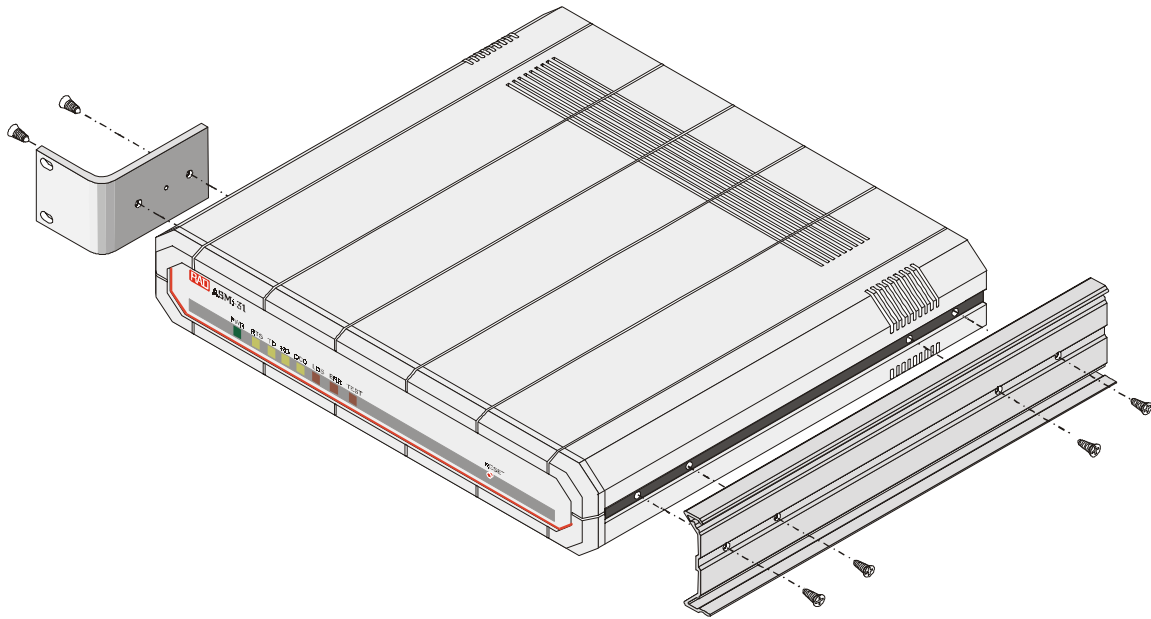
Figure F-2 Installation of Two Units

➤ **To install two units:**

1. Fasten one long side rail to each unit (right side to one unit, left side to the other unit) using the four screws supplied. The side rails must be attached in opposing fashion, the narrow flange of the first rail opposite the wide flange of the second rail.

2. Attach one short bracket opposite the side rail on each unit using the four screws supplied.

3. Slide the side rail of one unit into the side rail of the other unit, fastening the two units together (see *Figure F-3*).

4. Secure the supplied plastic caps to the ends of the rails, to prevent the units moving and to protect the rail ends.

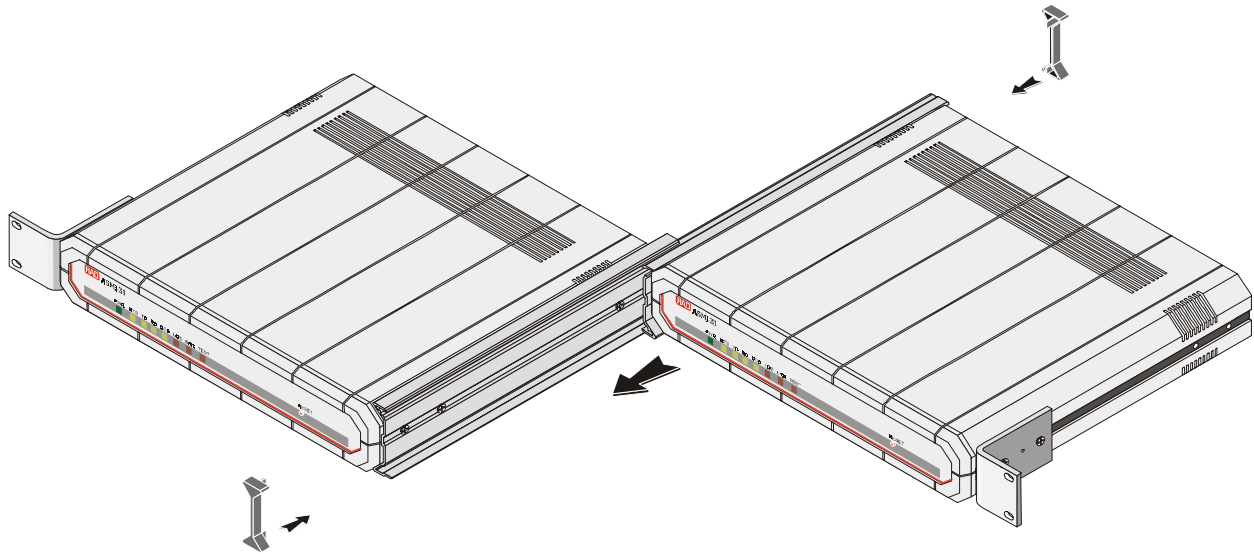The assembled units can now be fastened to the side rails of the 19" rack by means of four screws to each side(not included in the kit).

Figure F-3 Fastening Two Units Together